



PREDICTION OF ANNUAL MATERNAL MORTALITY RATE FOR SOUTH ASIA USING A MACHINE LEARNING METHOD

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Abstract

This research article employs annual time series data on MMR for South Asia from 1985 to 2023 to predict future trends of MMR over the period 2024 to 2035. The forecast evaluation criteria of the applied model indicate that the ANN (12, 12, 1) model is stable. The neural network model projections revealed that MMR will hover around 140 deaths per 100 000 live births throughout the out of sample period. Therefore, we encourage the government to adopt the suggested 5-fold policy prescription.

Keywords: ANN, Forecasting, Maternal Mortality Ratio.

Introduction

Maternal health is the health status of women during pregnancy, childbirth, and the post -partum period, which incorporates the health care dimension of family planning, preconception, and prenatal and postnatal care to reduce maternal morbidity and mortality (WHO, 2015). Then maternal death refers to death of a woman whilst pregnant or within 6 weeks of termination of pregnancy, regardless of the duration and the site of the pregnancy, from any causes related to or aggravated by the pregnancy or its management but not from accidental or incidental causes according to the World Health Organization (WHO, 2015). Most maternal deaths are recorded in low-middle countries. Approximately 830 women die every day globally as result of pregnancy-related causes, which can be avoided. Direct obstetric causes include hemorrhage and infection, while indirect causes encompass conditions like pregnancy-associated heart disease



(WHO, 2012). The global maternal mortality ratios (MMR) vary significantly due to factors such as individual behavioral traits, obstetric service accessibility/quality, socioeconomic/cultural contexts, and external environments (Mc Call et al. 2017). The World Health Organization estimated that 303,000 women worldwide will have died by the end of 2015 during and following pregnancy and childbirth. A recent World Health Organization report highlighted that maternal mortality has declined by 43% worldwide; however, maternal death is still high in sub-Saharan Africa and South Asia (WHO, 2023). Southeast Asia had an MMR of 134 per 100,000 live births in 2020, but internal disparities still exist. Countries like Indonesia, Myanmar, and Laos have persistently high regional MMR; Indonesia, for example, recorded an MMR of 249 per 100,000 live births in 2020 (Syairaji et al. 2024; Sysavanh et al. 2019; WHO, 2015). In 2023, roughly 260,000 maternal deaths were reported worldwide, with Southeast Asia contributing 20% (Lancet Reg Health Southeast Asia, 2023). The aim of this paper is to model and forecast MMR for South Asia using a machine learning technique. The study findings will facilitate crafting of regional policies and effective strategies that will further reduce preventable maternal deaths.

Literature Review

Author(s)	Objective(s)	Methodology	Key finding(s)
Feng et al. (2025)	To analyze trends (1990–2021) and projected (to 2050) MMR in Southeast Asia using the Global Burden of Disease (GBD) 2021 database, addressing gaps in regional granularity	Data GBD 2021, covering MMR and age-standardized MMR (ASMR) for 1990–2021, stratified by country, age group, and cause. Analysis: Trend assessment was conducted using the estimated annual percentage change (EAPC), while 30-year projections were generated via an autoregressive integrated moving average (ARIMA) model	Regional Trends: The ASMR in Southeast Asia fell by 59%, dropping from 255.88 in 1990 to 104.56 per 100,000 live births by 2021



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Soni et al. (2025)	to explore the prevalence of institutional delivery and its determinants in five South Asian countries	Data were extracted from five South Asian countries latest demographic and health survey data, including Afghanistan (2015), Bangladesh (2017–18), Nepal (2016), Myanmar (2015–16), and Pakistan (2017–18)	Women who didn't take any health care decision by-self had 16% lower chance of getting institutional delivery facility than others. Most importantly, rural area in south Asian countries presented lower odds of receiving healthy facility during delivery (OR 0.63, [0.59, 0.68])
Rahman et al. (2024)	to assess socioeconomic disparities in the utilization of health care services by mothers and to determine the factors influencing this utilization among women aged 15 to 49 in five South Asian countries	Applied logistic regression	Several socioeconomic and sociodemographic variables of the individual population, as well as policy issues, all have an impact on maternal mortality
Baig et al. (2023)	to examine and critically evaluate existing literature on perceptions and investigations regarding maternal mortality in Southeast Asia, Europe and Africa, utilizing the three delays model approach as a categorization framework	Systematic review	primary cause of maternal mortality is the first delay, which refers to the lack of awareness in seeking medical care. On the other hand, in Africa and other European countries, the second and third delays are more prominently associated with maternal mortality
Aziz et al. (2021)	To explore the relationship between health expenditure and maternal mortality by using data set consisting of 18 years from 2000 to 2017	Fully modified ordinary least squares (FMOLS) and dynamic ordinary least squares (DOLS) models were employed for the empirical analysis	The findings revealed that population growth has a significant long-term effect on maternal mortality—an increase of 40% in the case of FMOLS and 10% in the case of DOLS—and infers that an increase in population growth has also dampened efforts towards reducing maternal mortality in the South Asian panel



Sharma et al. (2018)	This was a systematic review on the effectiveness of community interventions in improving maternal health care outcomes in South Asia	Systematic review	Women's education interventions may improve the number of women seeking birth at a health care facility, but the evidence is of low quality
Girum and Wasie (2017)	to identify correlates of maternal mortality in developing countries	Scoping review	Maternal mortality is correlated with multiples of socio-economic factors, health care system associated factors, disease burden and their complex interactions
Bhandari (2012)	to assess the maternal and child health status in South East Asia Region	Systematic review	In the South East Asia, there is wide divergence in socio-economic and health status among the countries. More than one-third of maternal and child deaths of global mortality occurs in this region. Many countries in this region are unlikely to achieve the Millennium Development Goals 4 and 5 even if maternal child health is made the priority agenda of all the countries

Methodology

The Artificial Neural Network (ANN) approach, which is flexible and capable of nonlinear modelling; will be applied in this study. The ANN is a data processing system consisting of a large number of highly interconnected processing elements in architecture inspired by the way biological nervous systems of the brain appear like. Since no explicit guidelines exist for the determination of the ANN structure, the study applies the popular ANN (12, 12, 1) model based on the hyperbolic tangent activation function. This paper applies the Artificial Neural Network (ANN) approach in predicting annual maternal mortality ratio (MMR) for South Asia.



Data Issues

This study is based on annual MMR in South Asia for the period 1985 – 2023. The out-of-sample forecast covers the period 2024 – 2035. All the data employed in this research paper was gathered from the World Bank online database.

Findings of the study

ANN Model Summary

Table 1: ANN model summary

Variable	S
Observations	27 (after adjusting endpoints)
Neural Network Architecture:	
Input Layer Neurons	12
Hidden Layer Neurons	12
Output Layer Neurons	1
Activation Function	Hyperbolic Tangent Function
Back Propagation Learning	
Learning Rate	0.005
Momentum	0.05
Criteria:	
Error	0.016386
MSE	120.582368
MAE	4.382568

Residual Analysis for the Applied Model

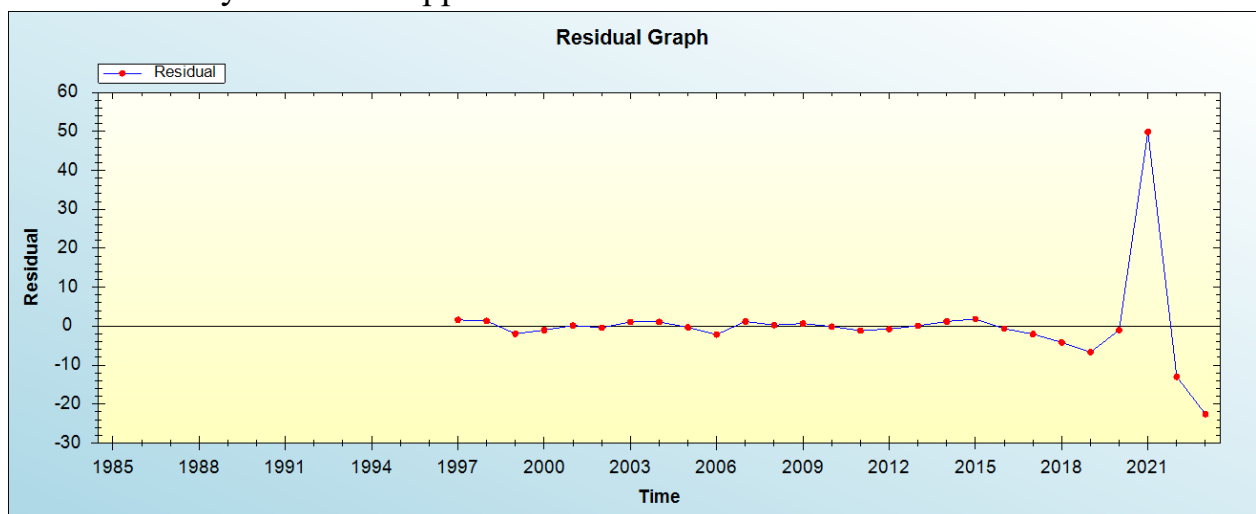


Figure 1: Residual analysis



In-sample Forecast for S

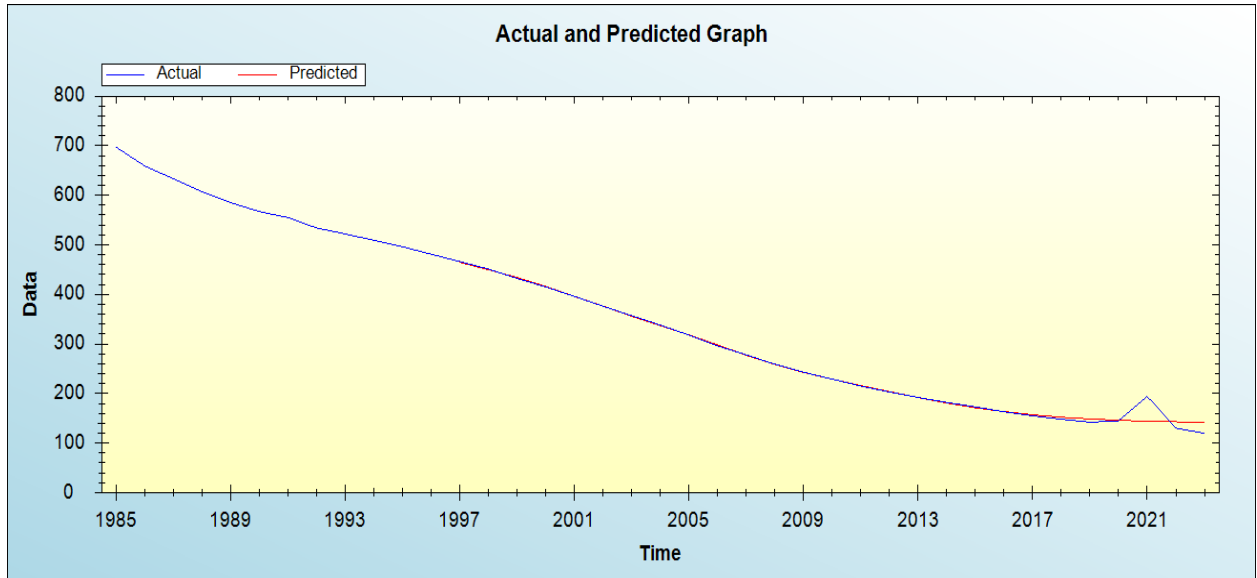


Figure 2: In-sample forecast for the S series

Out-of-Sample Forecast for S: Actual and Forecasted Graph

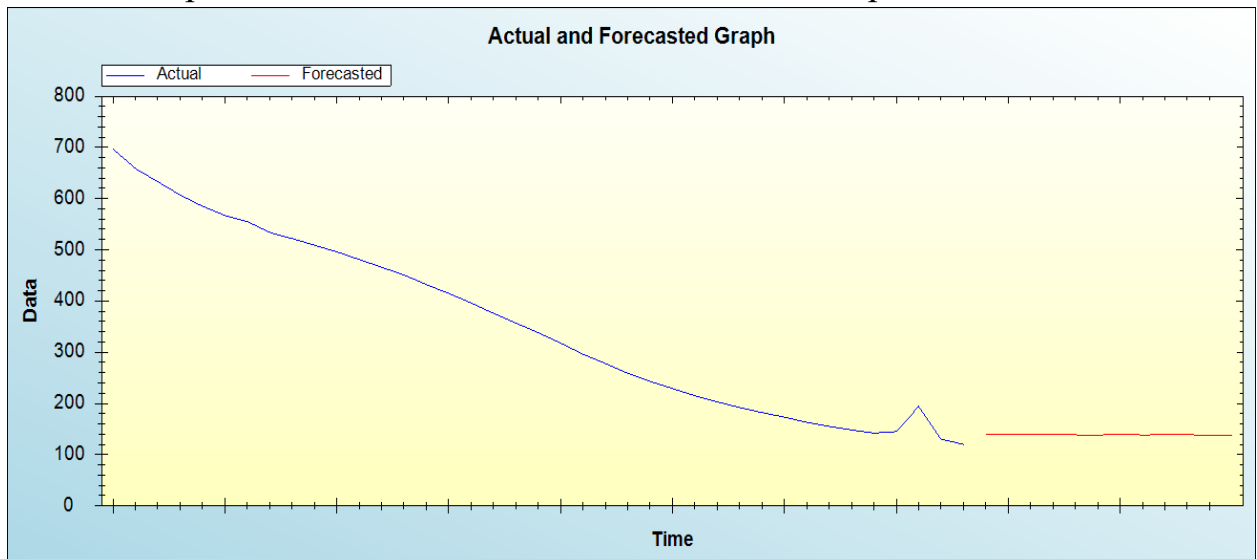


Figure 3: Out-of-sample forecast for S: actual and forecasted graph



Out-of-Sample Forecast for S: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted MMR
2024	140.5779
2025	139.8148
2026	139.5353
2027	139.9197
2028	138.6734
2029	138.2945
2030	139.2931
2031	138.3353
2032	138.7473
2033	138.8497
2034	137.9325
2035	138.0369

The main results of the study are shown in table 1. It is clear that the model is stable as confirmed by evaluation criterion as well as the residual plot of the model shown in figure 1. It is projected that annual MMR will hover around 140 deaths per 100 000 live births in the out of sample period.

Recommendations & Conclusion

The burden of maternal mortality in South Asia remains high. These high maternal mortality rates across the region highlight existing challenges which remain unresolved for decades. Factors associated with maternal deaths in the region include shortage of skilled birth attendants, long distance travelled to health facilities, inadequate medical supplies and medical staff incompetencies. In this study we applied a machine learning technique to model and forecast MMR for South Asia and results indicate that MMR is expected to hover around 140 deaths per 100 000 live births throughout the out of sample period. Therefore, we encourage authorities in the region to adopt the following policy prescription: (1) end adolescent pregnancy by enforcing laws that prohibit early child marriage, promote female education and comprehensive sexual and reproductive health education in schools (2) Improve coverage of maternal and child health services



across the region (3) carryout routine quality improvement activities (4) ensure availability of adequate medical supplies and medical staff in all medical facilities and (5) create posts for obstetricians in all government district hospitals so that specialist services are accessed at the first referral level. Alternatively, Registrars undergoing Obstetrics & Gynecology training can be attached at high volume district hospitals under the supervision of provincial consultants.

References

1. McCall S.J., Nair M., and Knight M (2017). Factors associated with maternal mortality at advanced maternal age: a population-based case-control study. *BJOG*. 2017;124(8):1225–33.
2. Syairaji M., Detty Siti Nurdiati., and Bayu Satria Wiratama (2024). Trends and causes of maternal mortality in Indonesia: a systematic review. *BMC pregnancy and childbirth*. undefined-undefined.
3. Sysavanh Phommachanh., Dirk Essink., and Maaïke Jansen (2019). Improvement of quality of antenatal care (ANC) service provision at the public health facilities in Lao PDR: perspective and experiences of supply and demand Sides. *BMC pregnancy and childbirth*.
4. The Lancet Regional Health-Southeast Asia. Life-course approach for maternal and child health: much to do. *Lancet Reg Health Southeast Asia*. 2023; 15:100263.
5. WHO (2015). Health in 2015 from MDGs to SDGs. Geneva.
6. WHO (2023). The Global Health Observatory Explore a world of health data [Internet]
7. World Health Organization (2012). ICD-10: international statistical classification of diseases and related health Problems—Application to deaths during Pregnancy, childbirth and the puerperium (ICD-MM). Geneva
8. World Health Organization (2015). (WHO) Factsheet/maternal health topic.